Small Business Innovation Research/Small Business Tech Transfer

Low Impulse Bit Electrospray Thruster Control, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Busek proposes to develop a new form of passive electrospray thruster control which will enable extremely fast thruster operations and thereby unprecedented minimum impulse bits. Busek's BET-300-P thruster is under active development as a precision reaction control system (RCS) which will provide orders of magnitude improvements over state-of-the-art alternative attitude control systems (ACS) for CubeSats and small spacecraft. The low inertia of CubeSats combined with vibrational disturbances and resolution limitations of state-of-the-art ACS presently limit precision body-pointing and position control. Busek's electrospray thrusters aboard the ESA LISA Pathfinder (NASA ST-7) spacecraft, recently demonstrated control of a proof mass location to within ~2nm per root Hz over a wide band. The BET-300-P, enhanced by exploitation of its high-speed dynamic response in this program, seeks to extend that success to small spacecraft platforms.

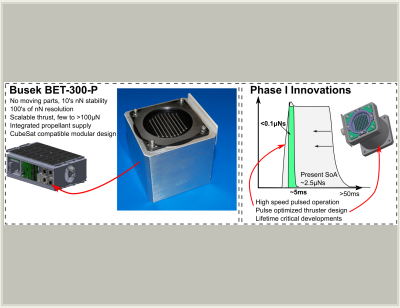
Passively fed electrospray thrusters are highly compact, including fully integrated propellant supplies, and are capable of ~100nN thrust precision with 10's of nN noise. Thrust can be accurately throttled over >30x, up to a scalable maximum of 10's to 100's of uN. While typically operated in largely continuous states they are unique in that emission can be electrically stopped/started at ms time scales. Thus, extremely low impulse bits may be achieved over very short durations, permitting throttling from <0.1uNs up to 100's of uNs. Realization of this fundamental capability of the technology is presently limited by control circuitry. The proposed work seeks to study and overcome these limitations with a new control methodology.

These traits, combined with >800s specific impulse, and thereby low propellant mass could enable these systems to replace traditional reaction wheel ACS and high-propellant mass cold gas systems; enabling milliarcsec control authority for CubeSats versus the present arcsec level SOA.

Anticipated Benefits

Ongoing NASA mission studies include the BET-300-P for attitude control, formation flight and positioning of small spacecraft. Specific benefiting applications include deep-space missions, astronomy, solar-system observations, laser communications and space situational awareness. Mission durations are extended by increased wheel desaturation capacity. Improved body pointing would augment stability; permitting lower cost/complexity realization of existing needs and enabling new objectives.

Compact propulsion systems that are scalable in thrust and ΔV are an enabling technology for CubeSats and therefore have numerous commercial applications. The virtual elimination of vibrations while superseding reaction wheel precision is a clear competitive advantage. The precision pointing/positioning capabilities of the BET-300-P system are otherwise unavailable. Potential non-NASA customers include, international partners



Low Impulse Bit Electrospray Thruster Control, Phase I

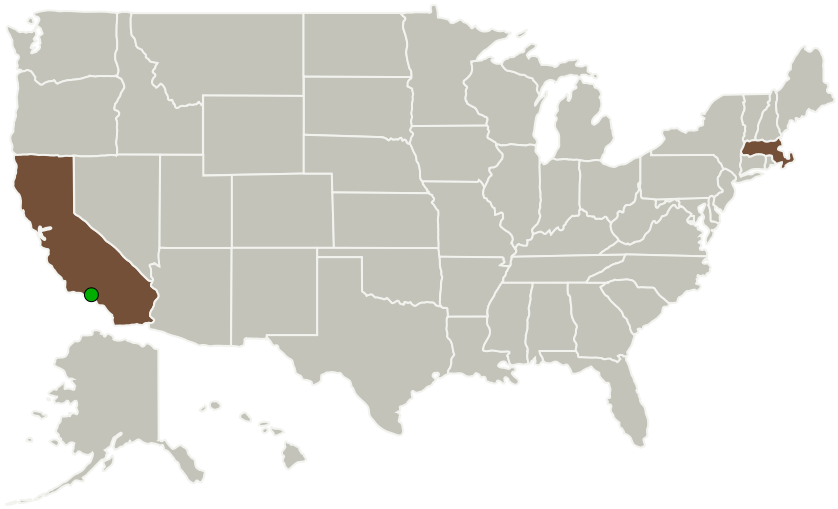
Table of Contents

Low Impulse Bit Electrospray Thruster Control, Phase I

Completed Technology Project (2018 - 2019)

(such as ESA), the DoD and commercial EO missions.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Busek Company, Inc.	Lead Organization	Industry Women-Owned Small Business (WOSB)	Natick, Massachusetts
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Massachusetts

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Busek Company, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

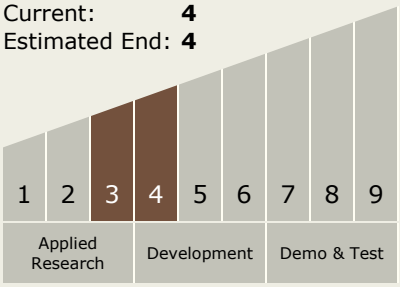
Carlos Torrez

Principal Investigator:

Daniel Courtney

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Low Impulse Bit Electrospray Thruster Control, Phase I

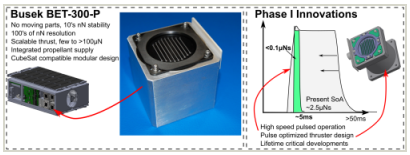
Completed Technology Project (2018 - 2019)

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141158)*

Images



Briefing Chart Image
Low Impulse Bit Electrospray Thruster Control, Phase I *(https://techport.nasa.gov/image/136890)*

Final Summary Chart Image
Low Impulse Bit Electrospray Thruster Control, Phase I *(https://techport.nasa.gov/image/126958)*

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.2 Electrostatic

Target Destination

Earth